Accessible Regions of Interest within Southwestern Melas Basin for Exploration and Sample Collection by the 2020 Mars Rover

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Aqueous History

Subaerial

Purple = Fan/deltas

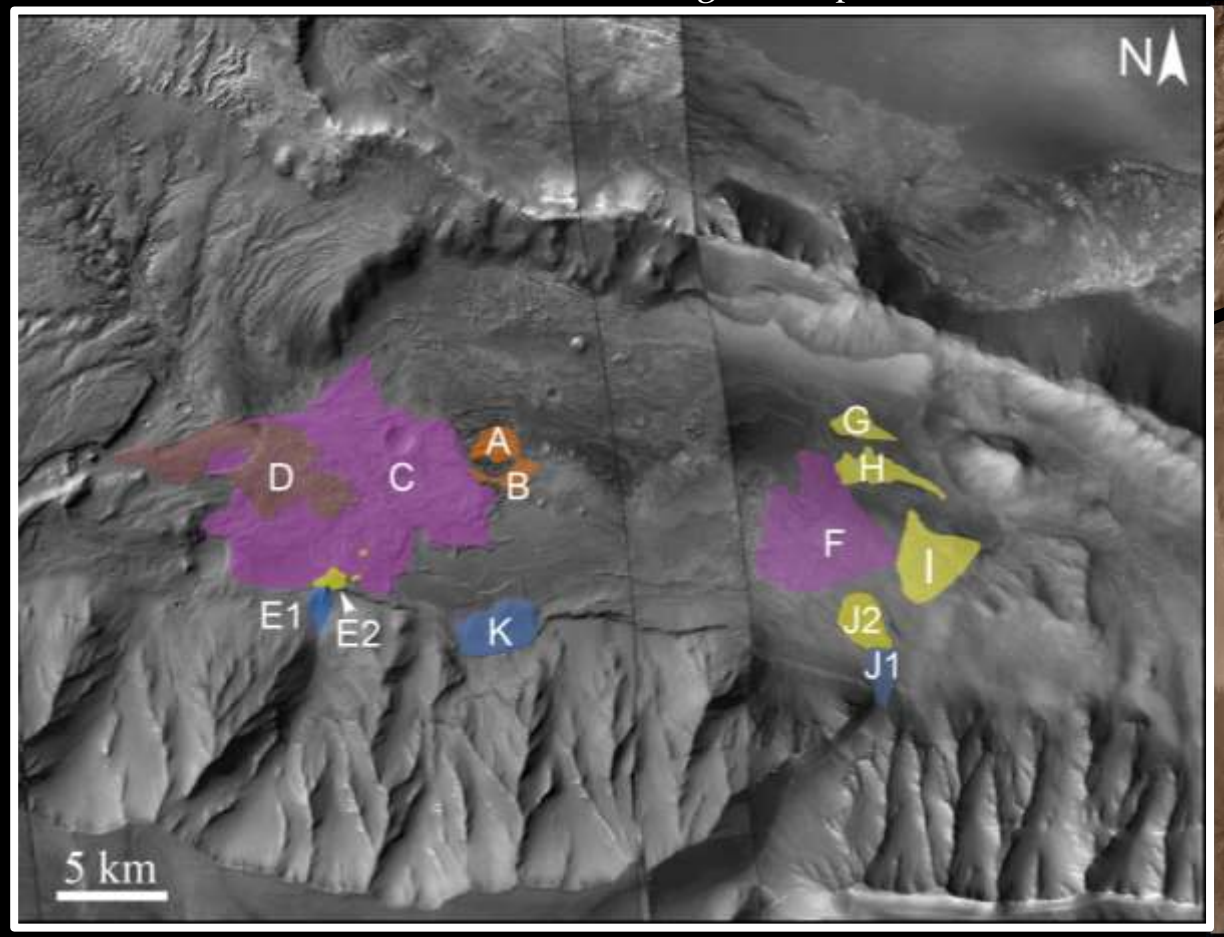
Blue = Landslides

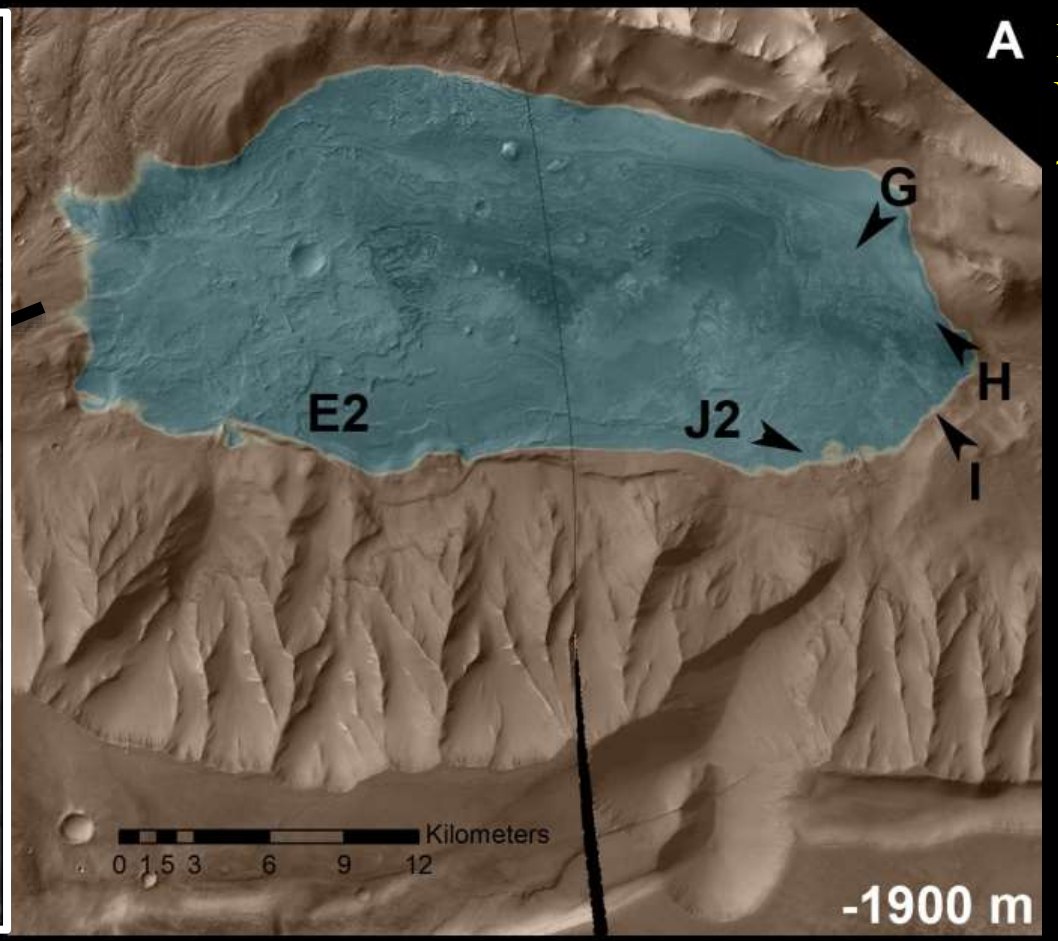
Brown = Debris flows

Subaqueous

Yellow = Deltas

Orange = Deep sublacustrine fans



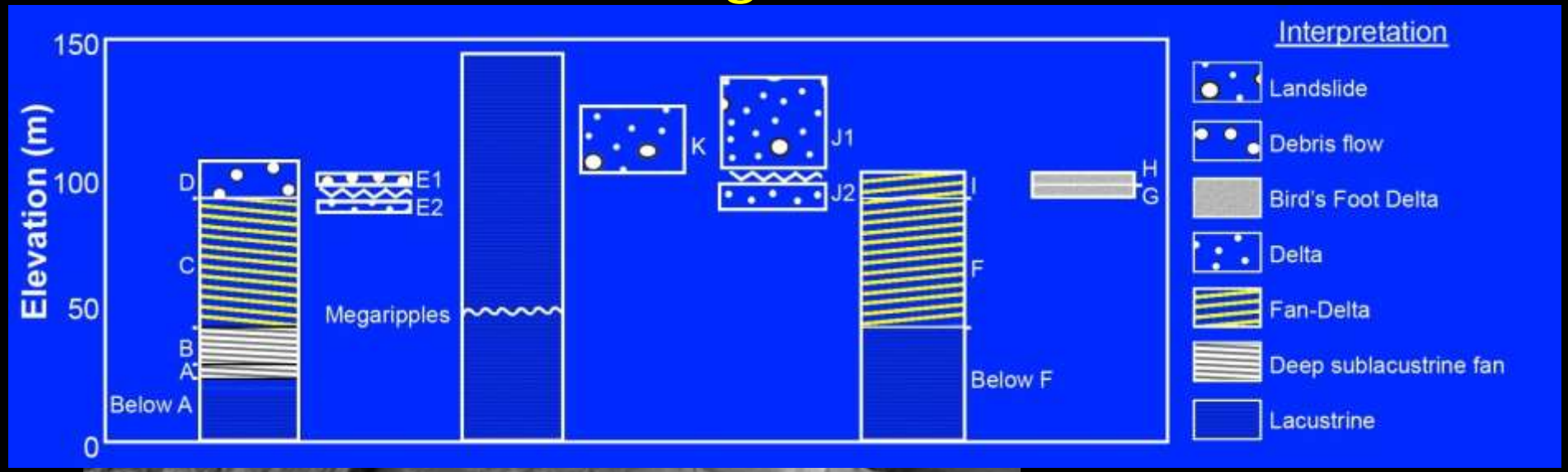


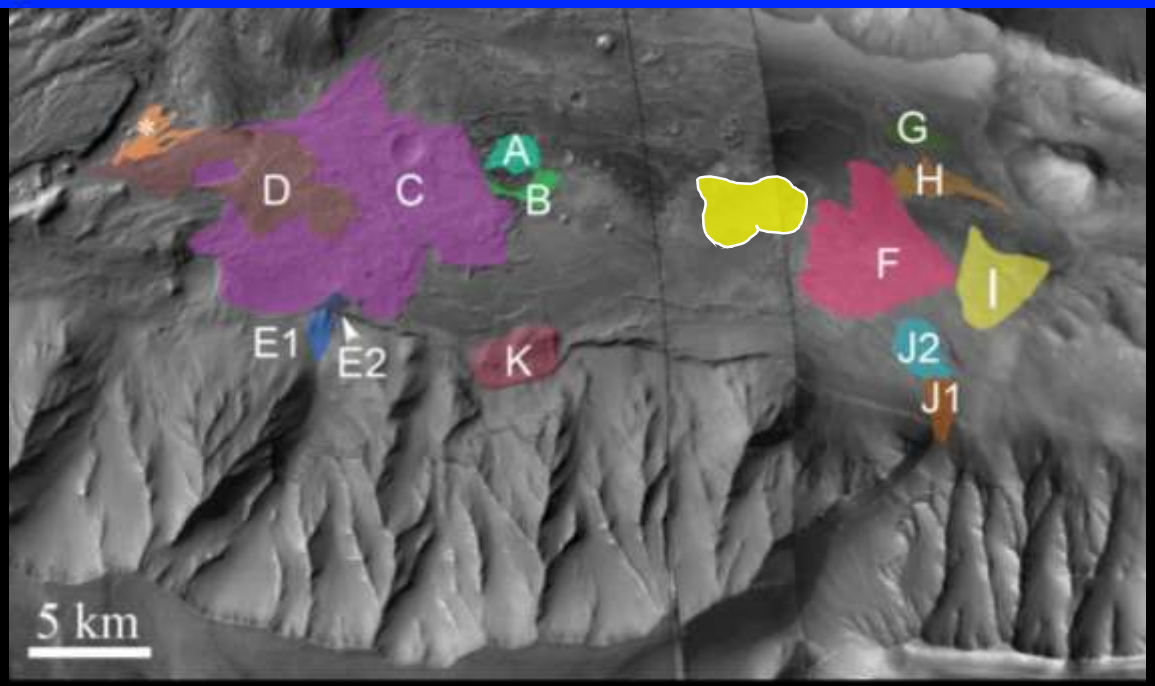
A Lake Volume ~157 km^3

Max. Depth 415 m

(Quantin et al., 2005; Metz eta l., 2009; Williams and Weitz, 2014)

Stratigraphic relationships define aqueous history with inferred 2 lacustrine highstands





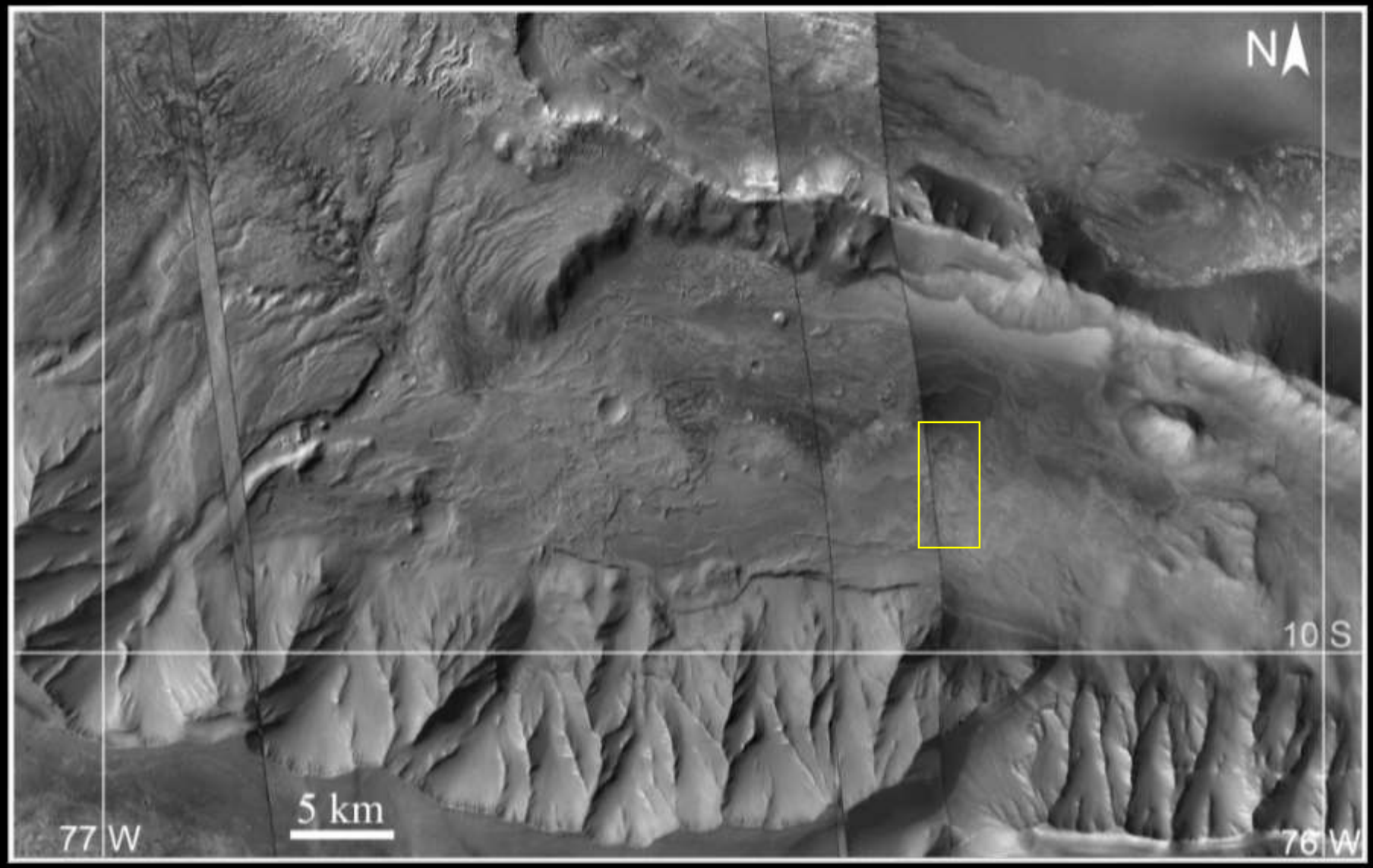
Thickness of section tied to timescales of lacustrine activity: Centuries to millenia

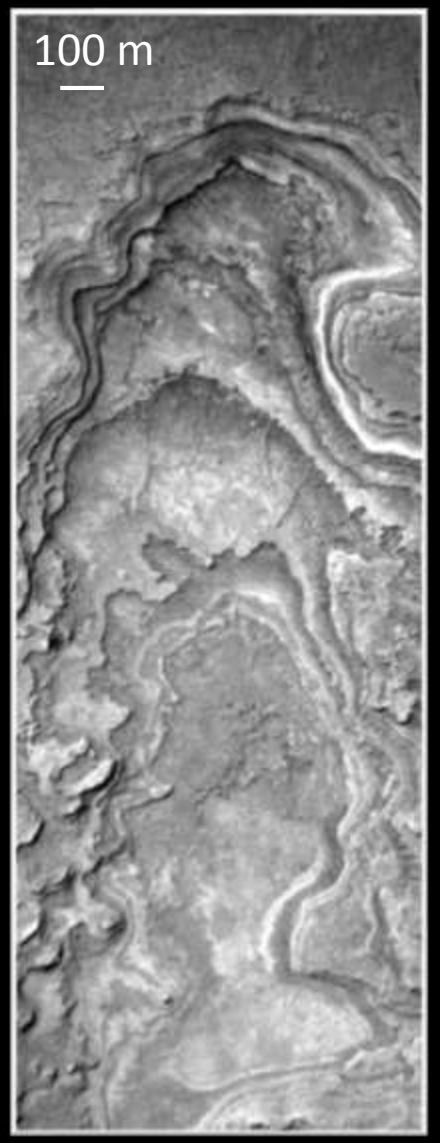
(Williams and Weitz, *2015*)

Environmental Setting for Biosignature Preservation and Taphonmy of Organics

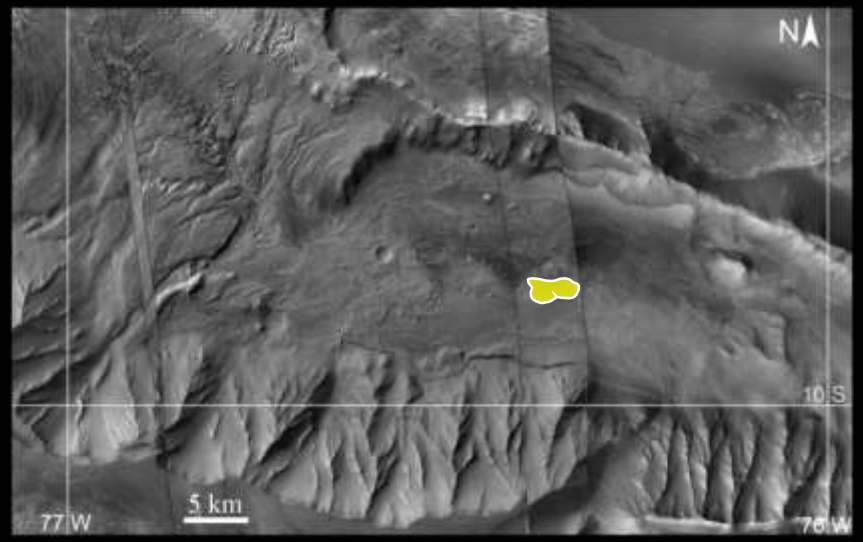
ROI: Layered materials, interred lacustrine deposits
Possible volcanic ash?

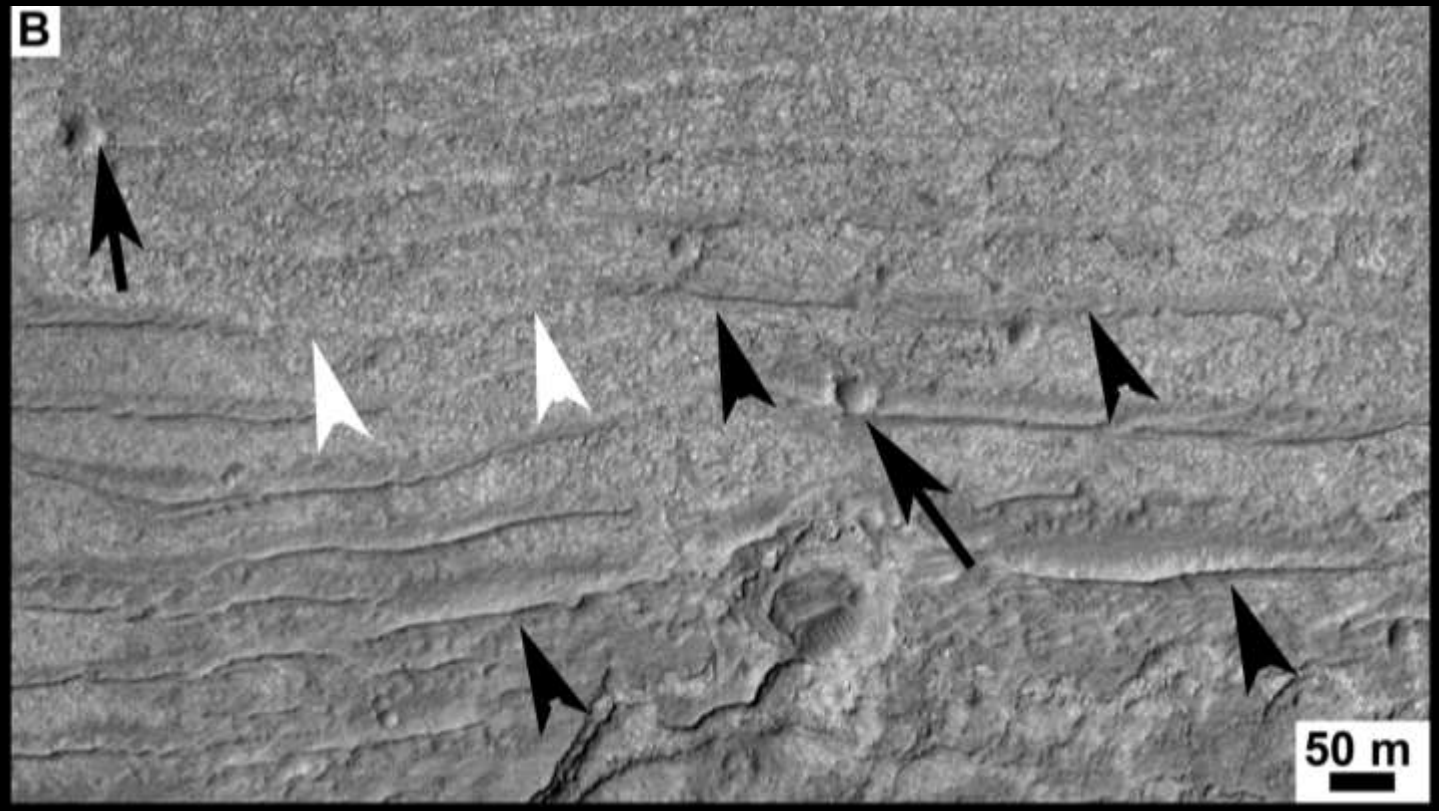
Deltaic or Lacustrine (perennial)	Pedogenic
Lacustrine (evaporitic)	Stratigrapy of units well-defined





Indurated Aeolian Bedforms





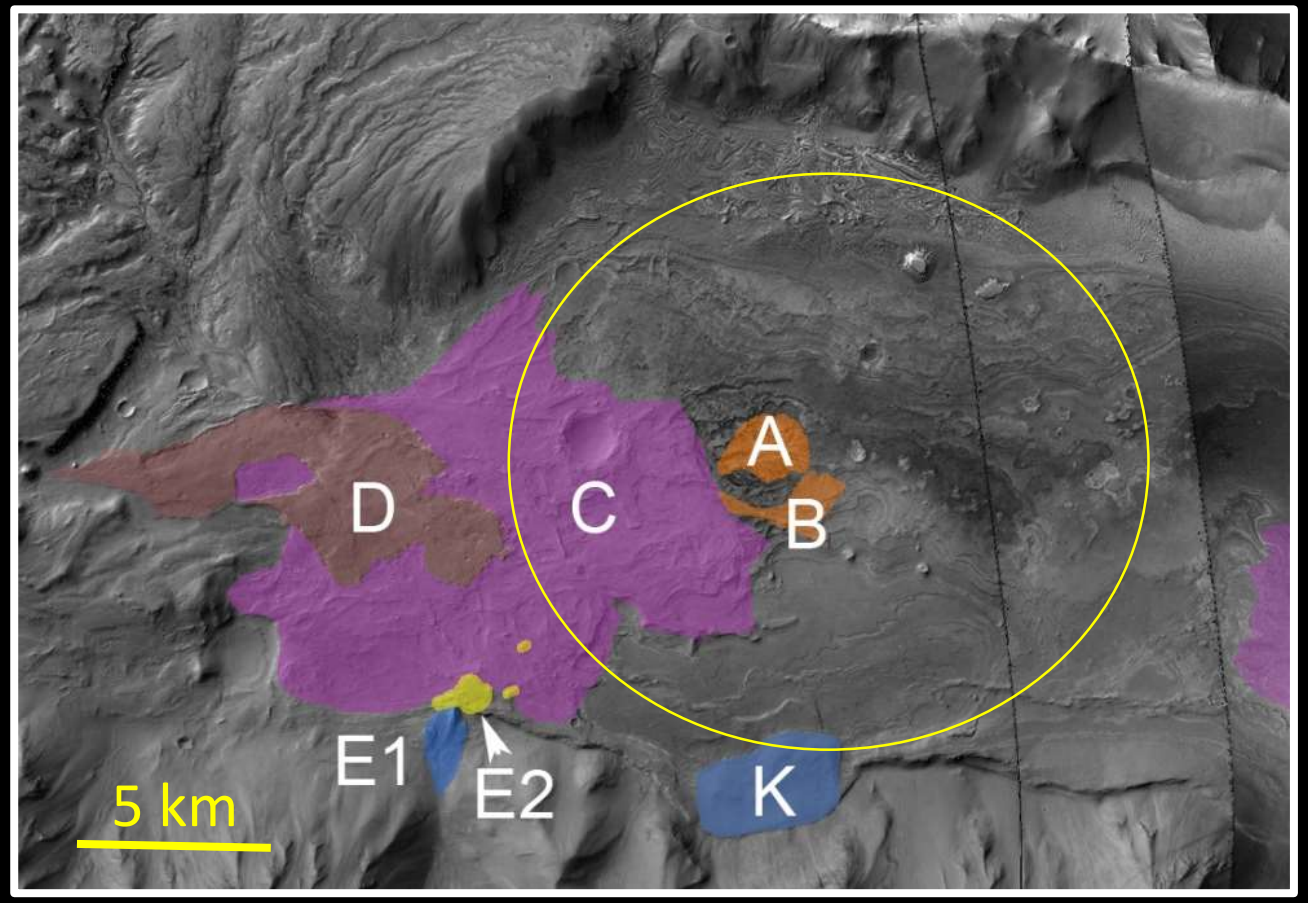
λ = 30-40 m

Sharp-crested ridges (black arrows) superpose round ridges (white arrow)

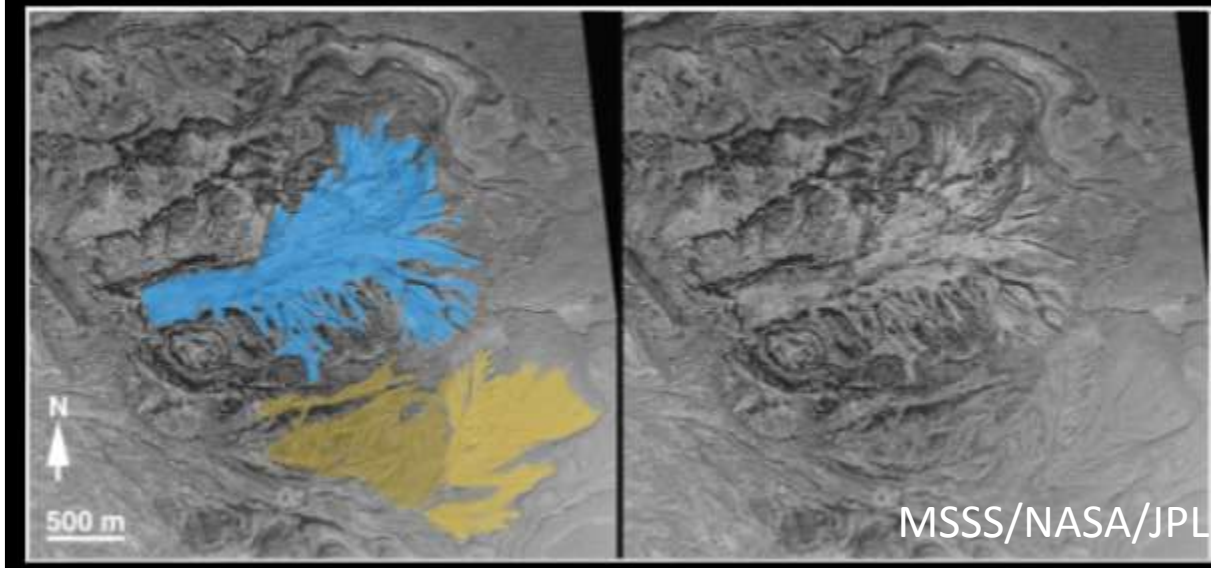
Environmental Setting for Biosignature Preservation and Taphonmy of Organics

●	Fluvial/Alluvial
●	Recent exposure

ROI: Fan-Delta, Delta, Deep Subaqeuous Fan, Landslides

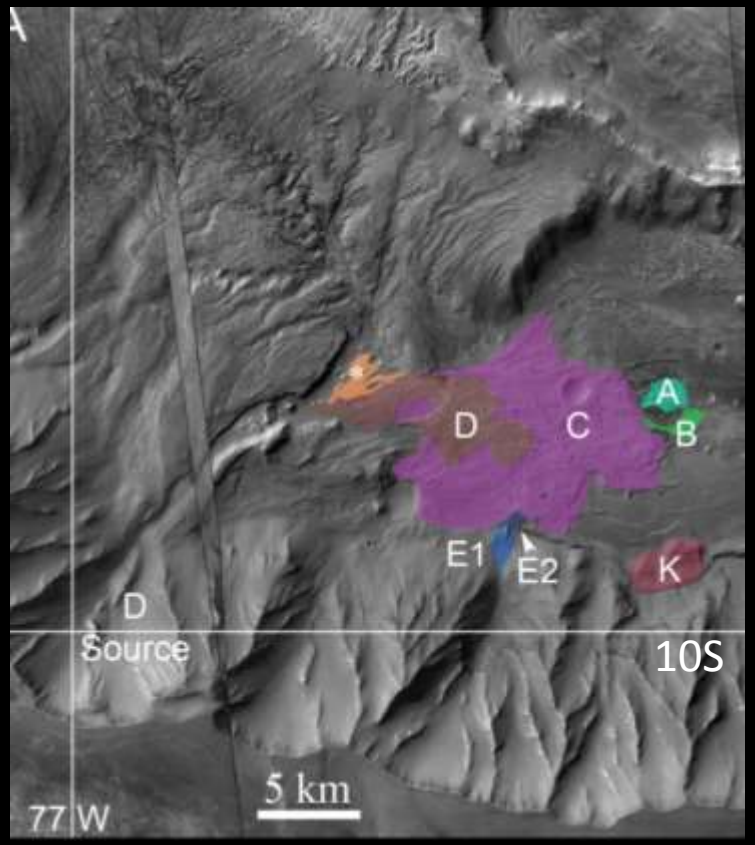


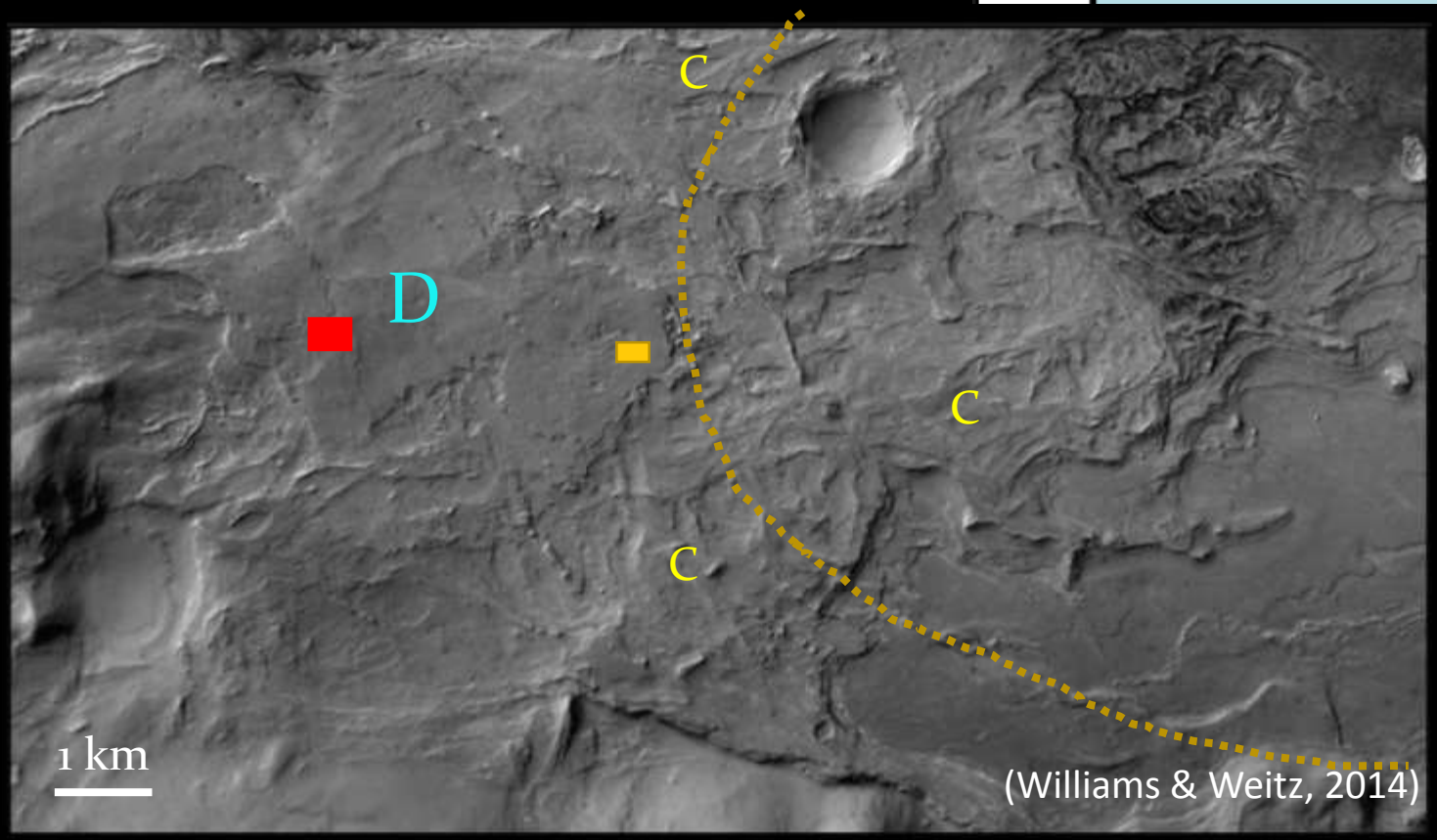
Erosional window



(Williams and Weitz, Icarus, 2014; Metz et al, 2009)

Source Regions

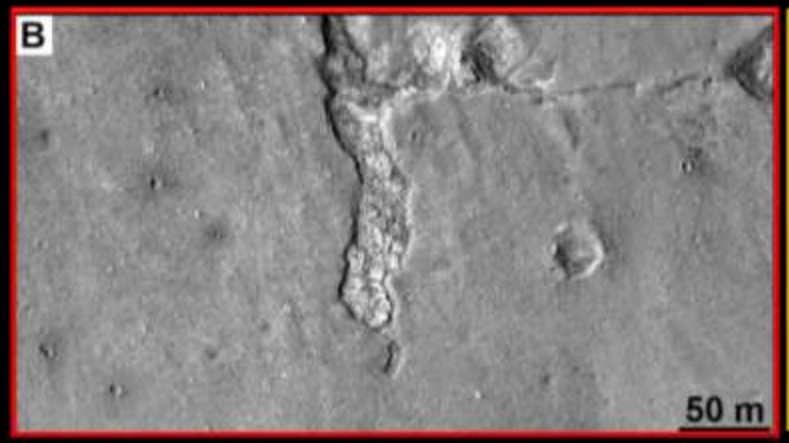


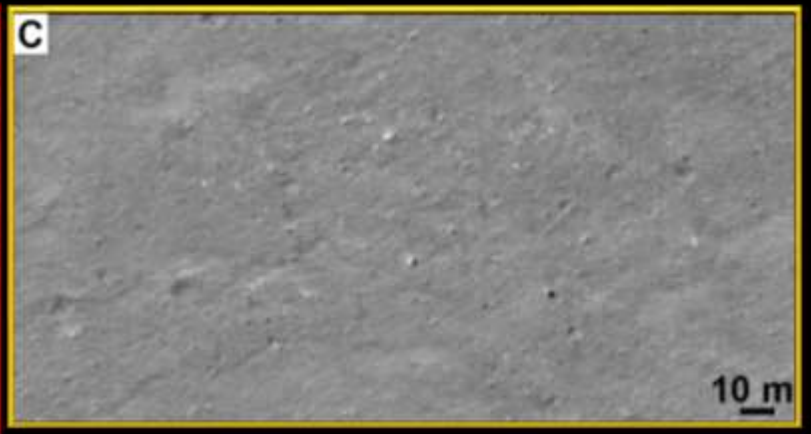


Fluvial/Alluvial

ROI: Debris Flow (outside ellipse)

Fan D Debris Flow



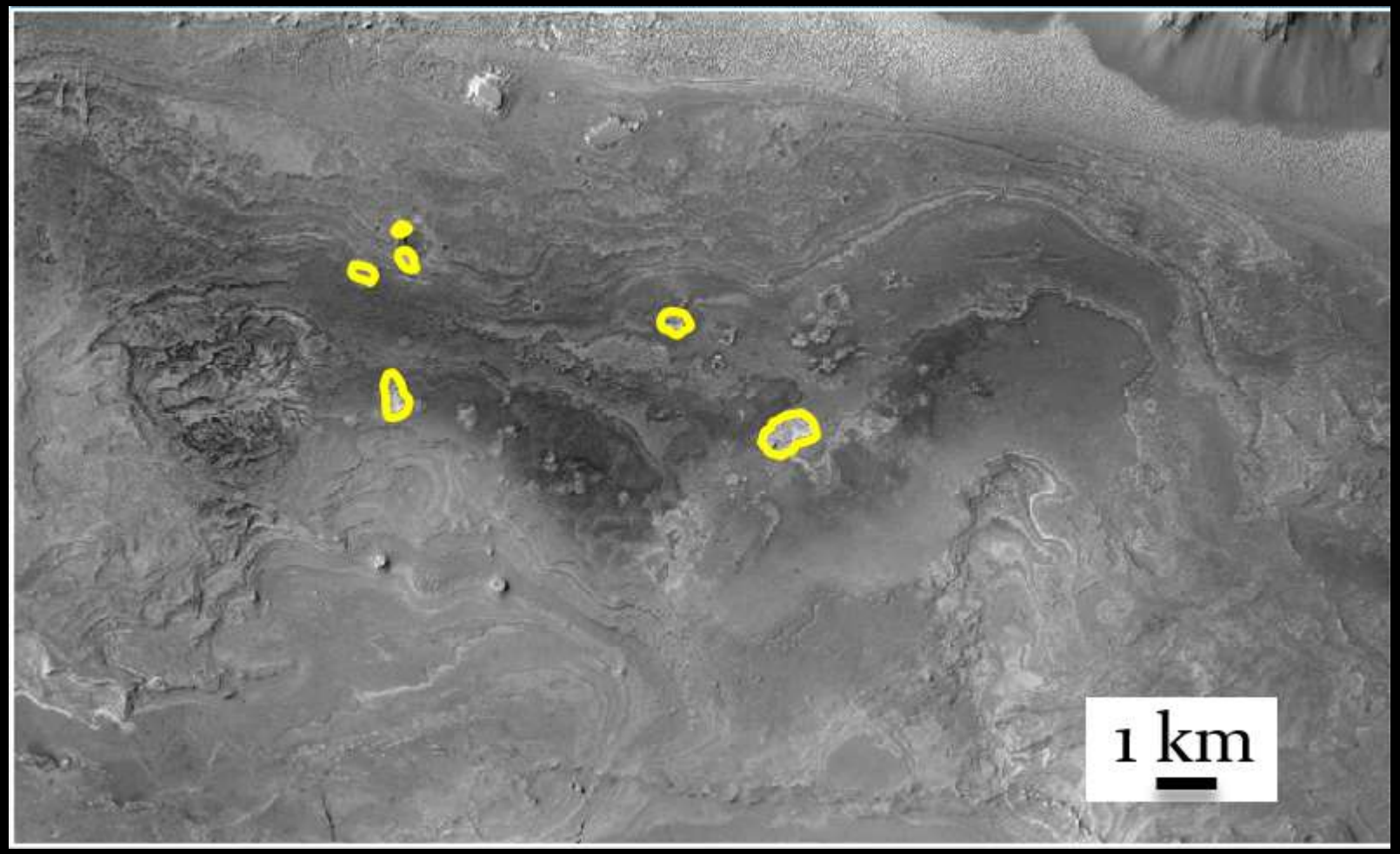


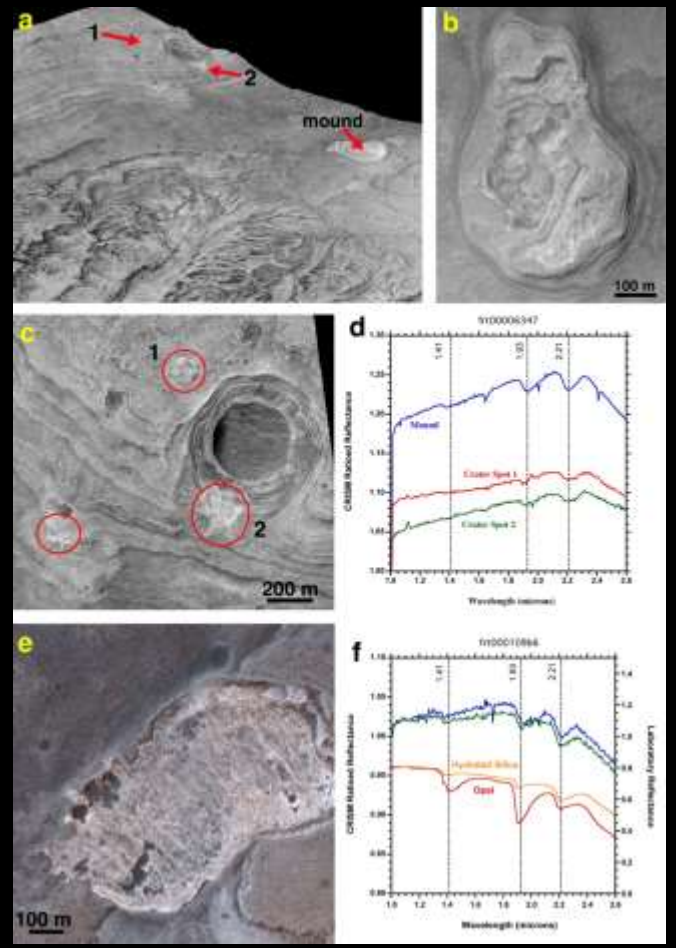
Environmental Setting for Biosignature Preservation and Taphonmy of Organics

~	Hydrothermal (<100°C) subsurface
?	No diagenetic overprinting

ROI: Hydrated Silica (Opal)

Hydrated silica associated with isolated, bright outcrops





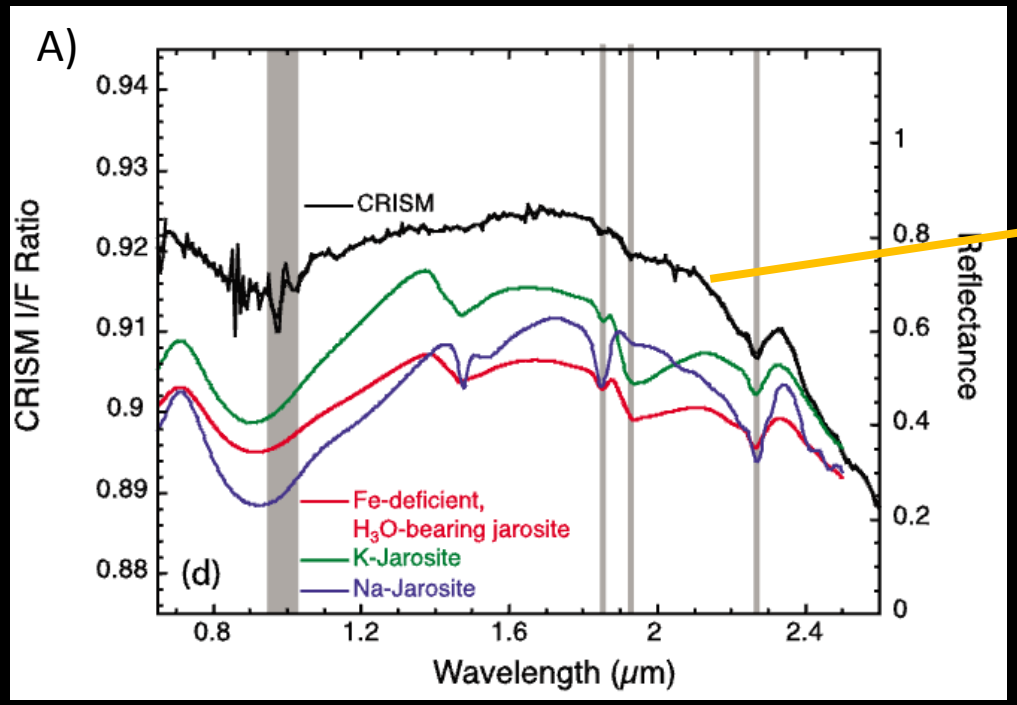
(Weitz et al., Icarus, 2014; Williams and Weitz, Icarus, 2014)

Aqueous Geochemical Environments Indicated by Mineral Assemblages

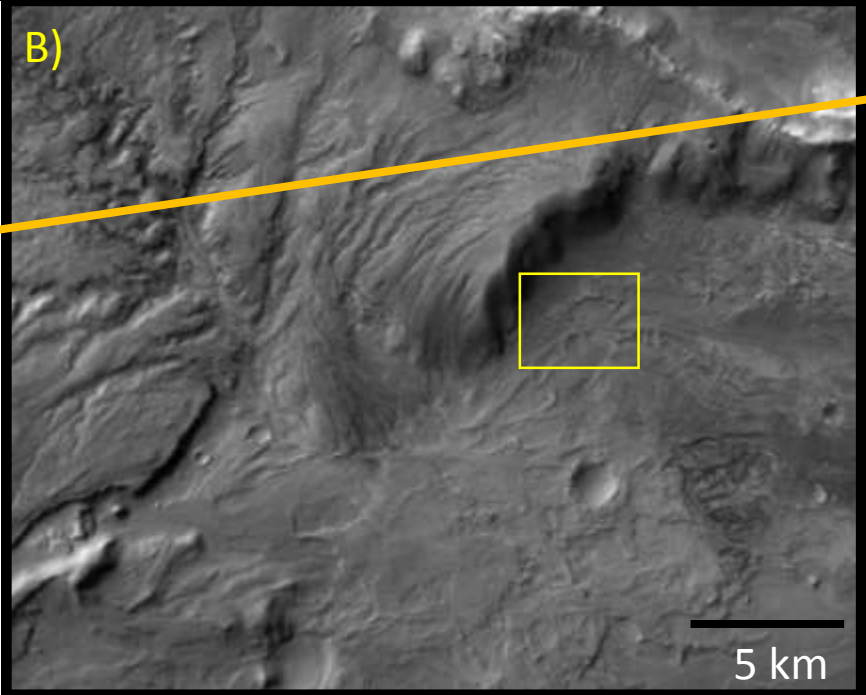
ROI: Clinoform & Sulfate deposit (outside ellipse)

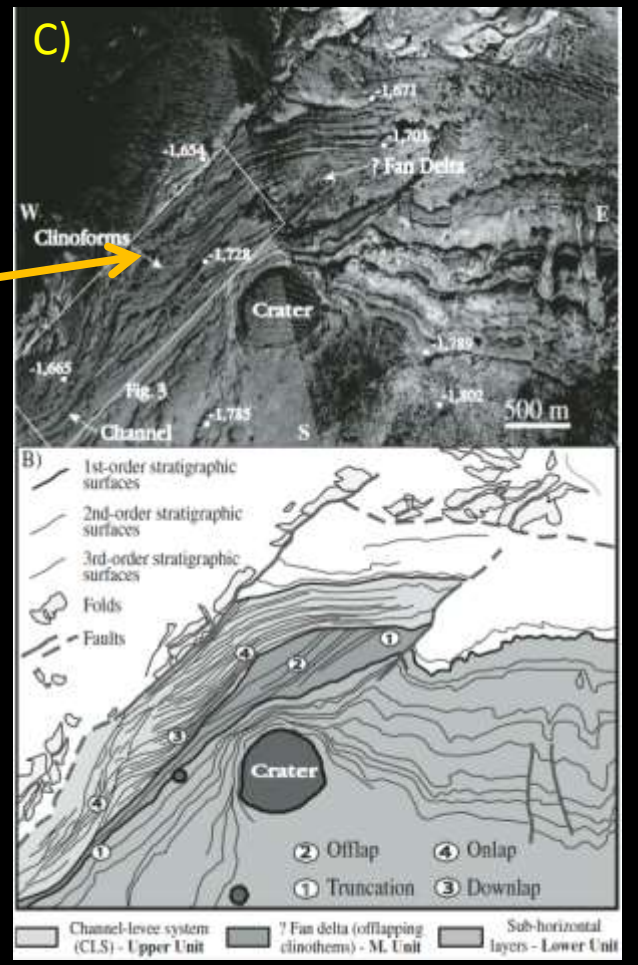
●	Sulfate sediments
?	Al clays in stratigraphy
?	Ferric Ox./Ferrous clays

Jarosite



(Metz et al., 2009)

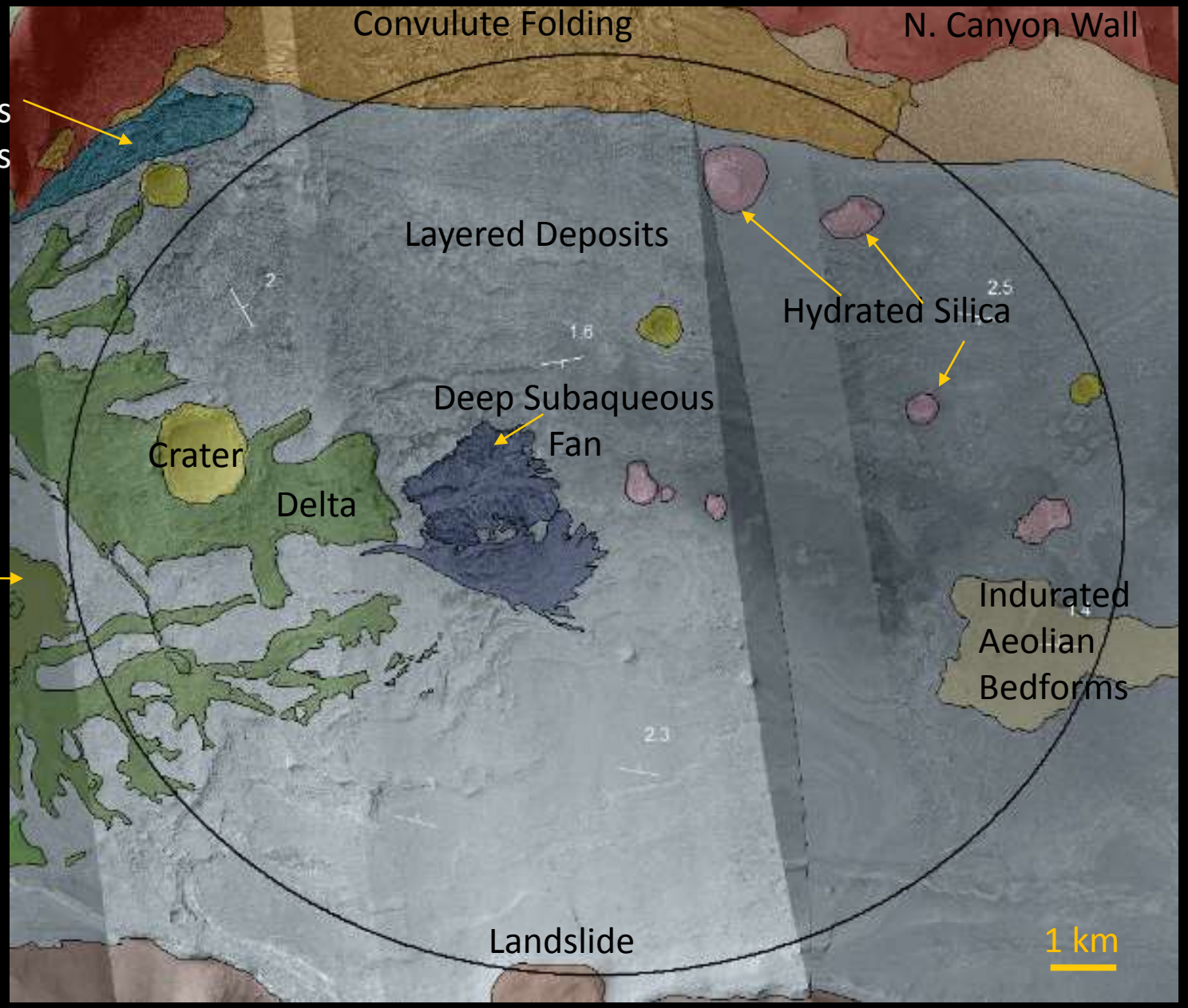




(Dromart et al., 2007)

Geomorphic Map

7 ROIs within landing ellipse



Regional map in Supplemental slides

Joel Davis

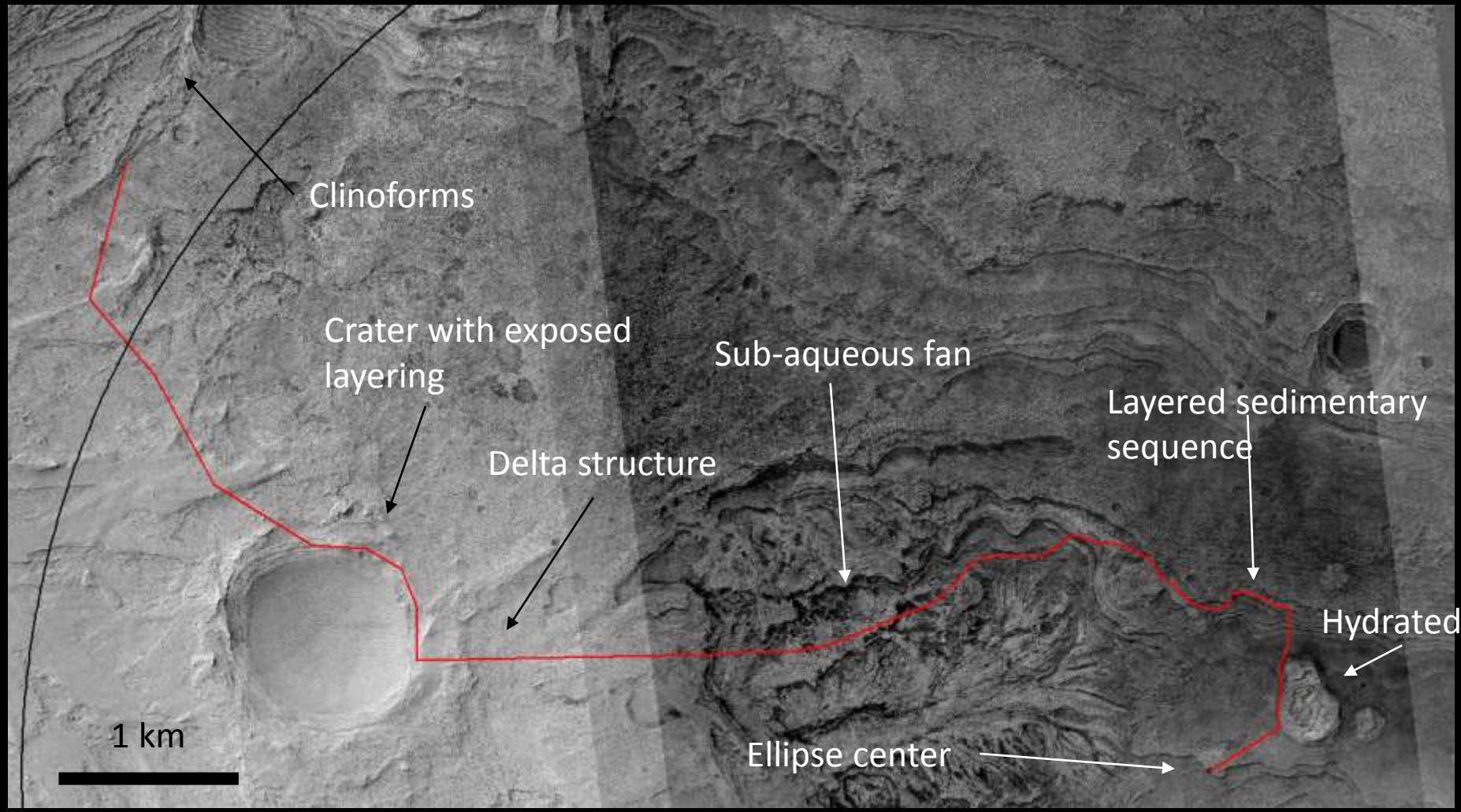
Engineering Constraints

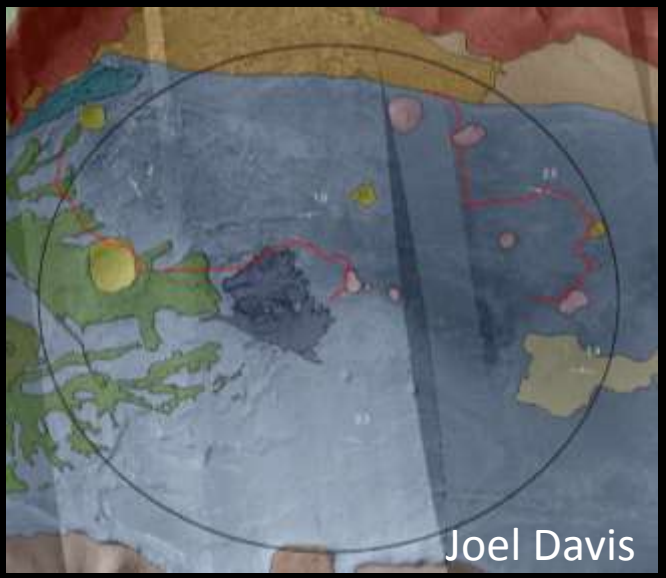
Slope Map

Joel Davis

Parameter	Criteria	Compliance
Elevation	Below 0.5 km	√ -1.850 +/- 0.100 km
Latitude	Within ±30° of the equator	√ 9.84°S, 283.63°E
Slope	<20° over 2-10 km	√
	<25° over 2-5 m	√
Relief	<100 m over 1-1,000 m	Small region at southern extent of ellipse.
Rock Abundance	Probability of rock 0.55 m tall in area of 4 m^2 is <0.5%	HiRISE verification needed
Thermal inertia	> 100 J m^{-2} $s^{-0.5}$ K^{-1}	√
Albedo	<0.25	√

Example Traverse 1: Ideal landing at ellipse center



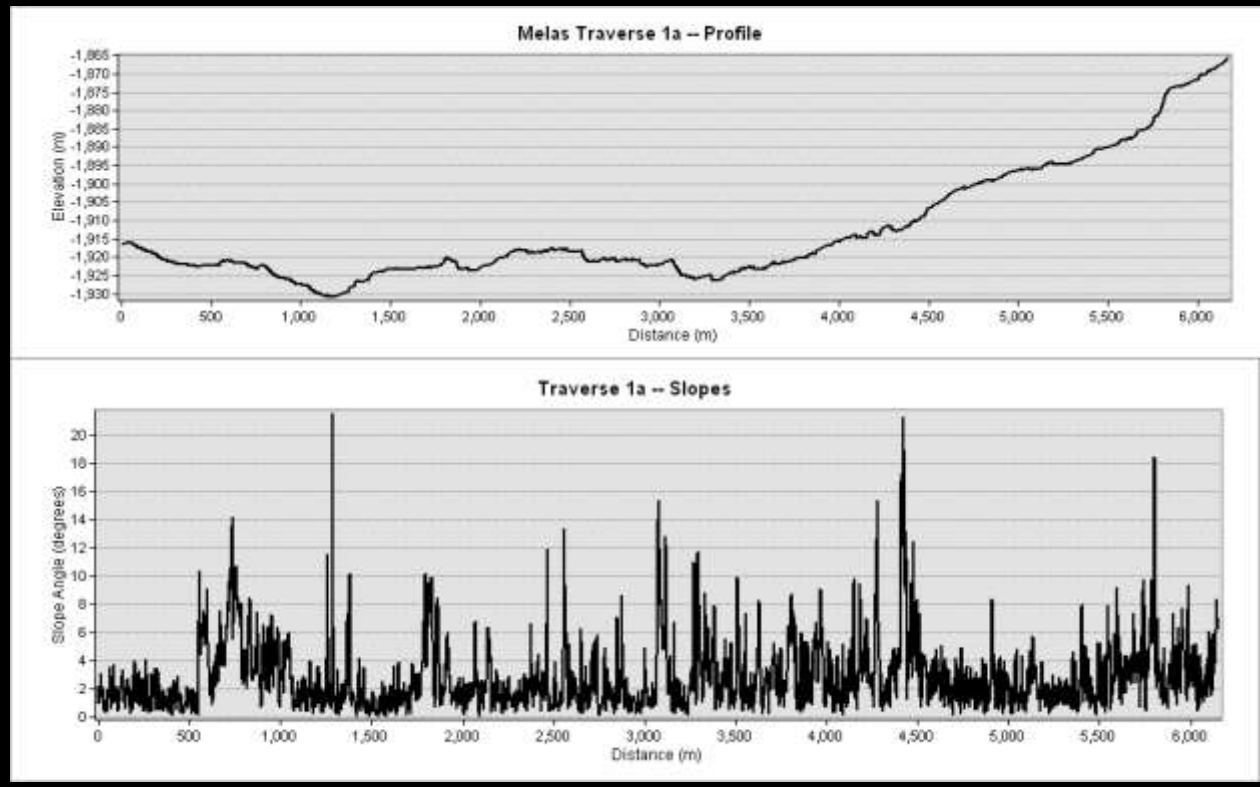


~ 12.5 km traverse with 6 ROIs

Contributed by Joel Davis

Example Traverse 1 – Good terrain traverseability

DEM error



65 m elevation
All slopes below 25 degrees

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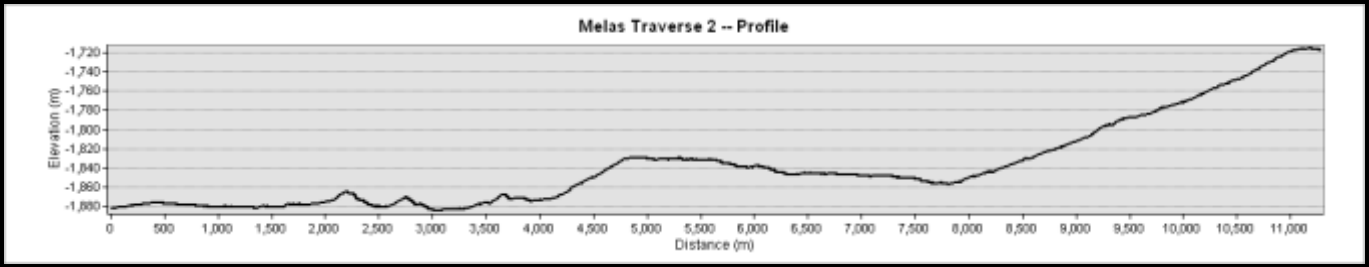
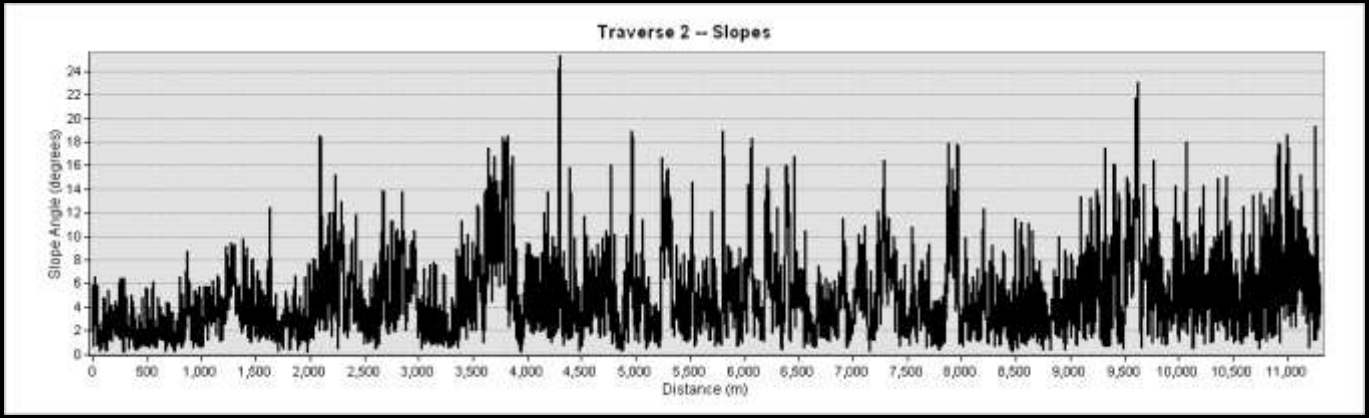
Example Traverse 2: eastern landing

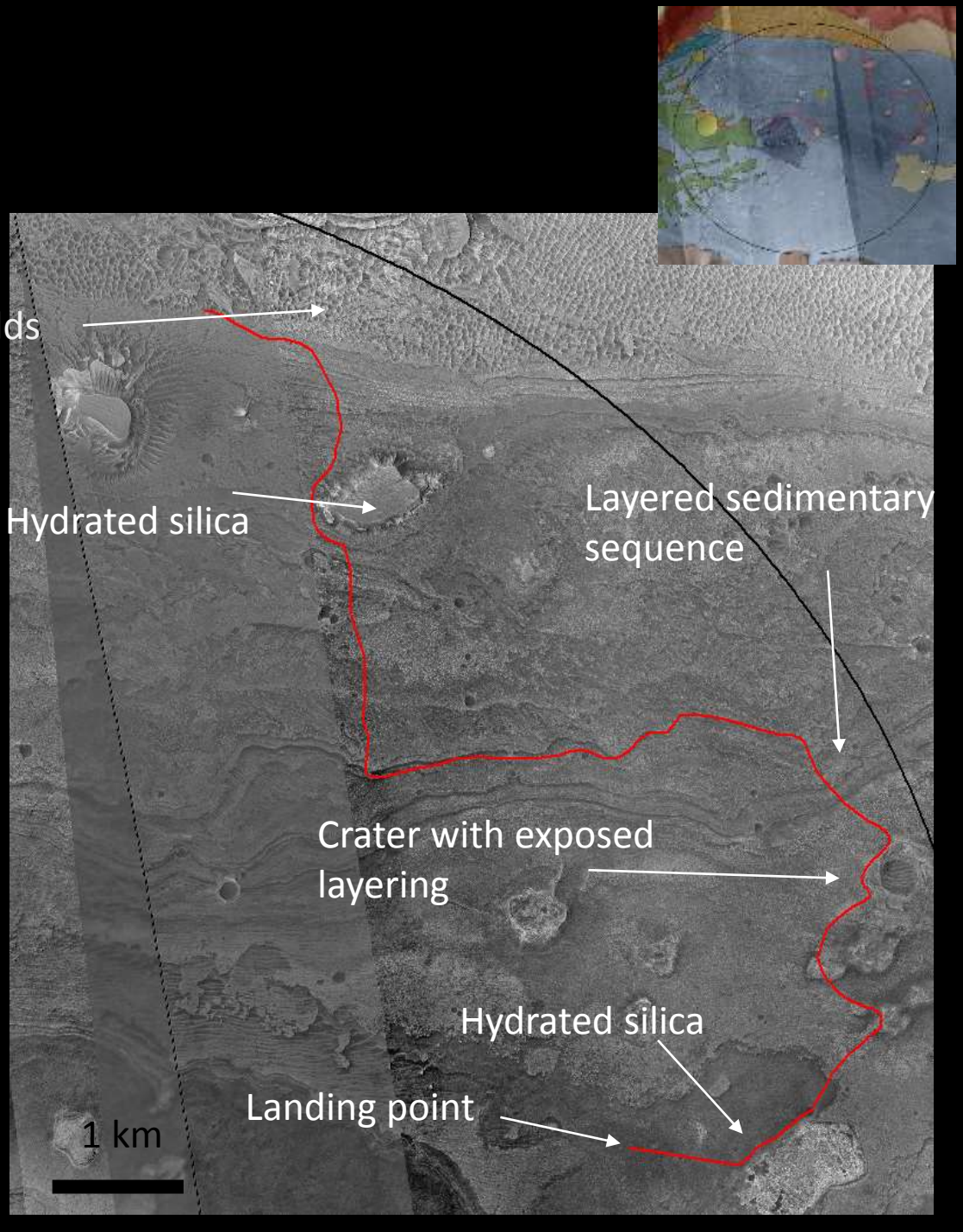
~ 11.3 km traverse

4 RoIs within ellipse

~160 m elevation gain







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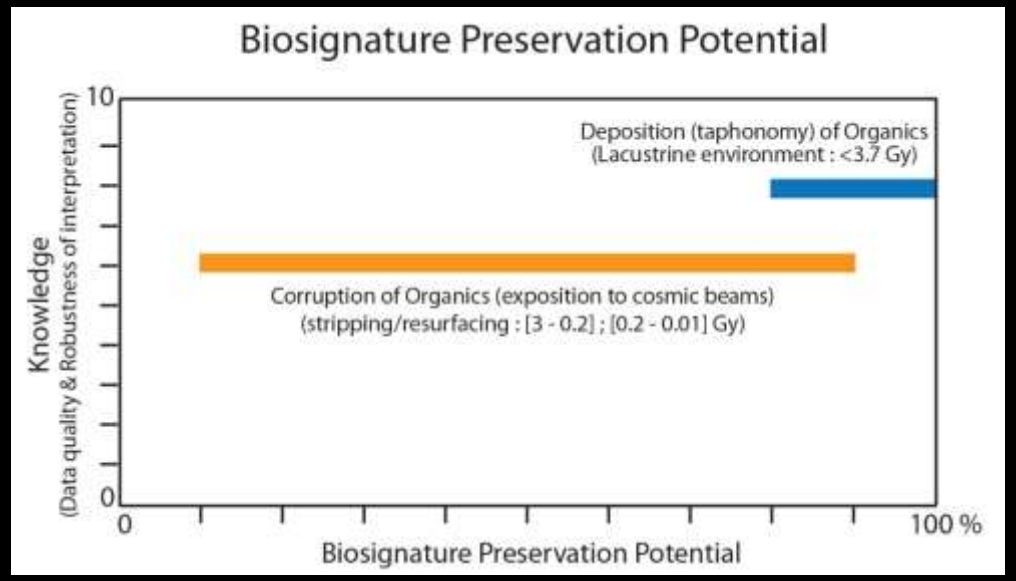
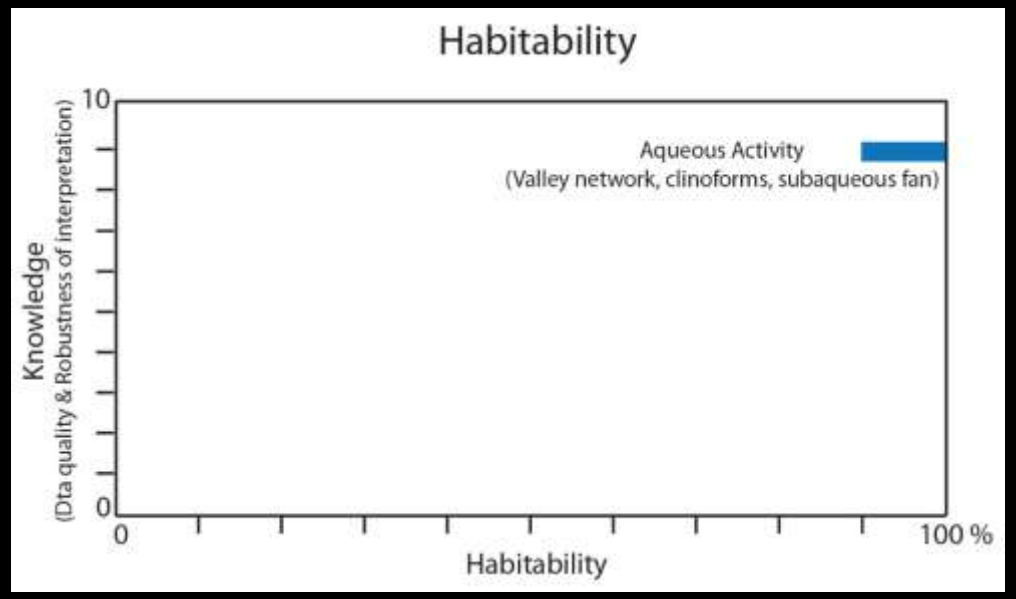
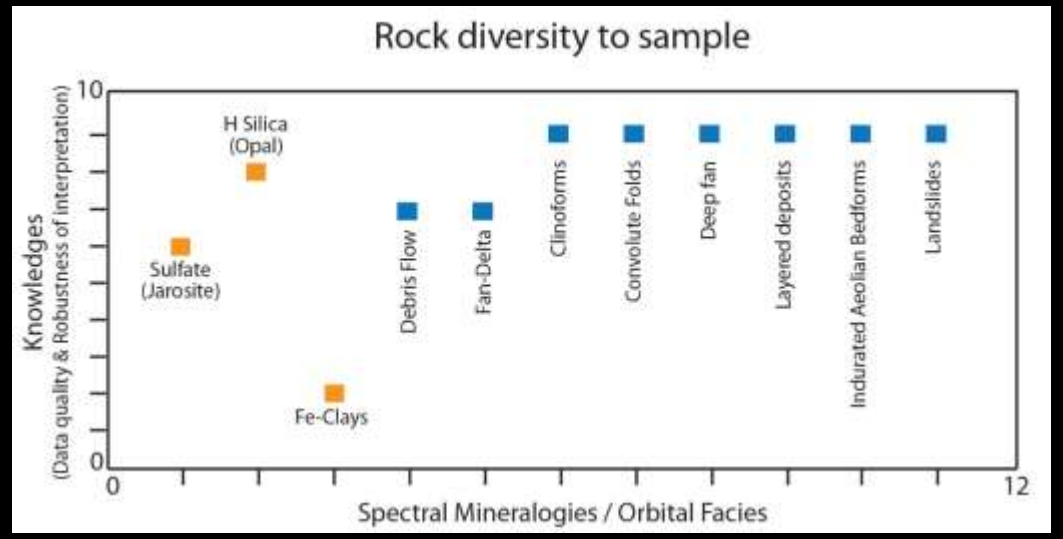
Summary Assessment Plots







Contributed by Gilles Dromart

SW Melas Summary Slide

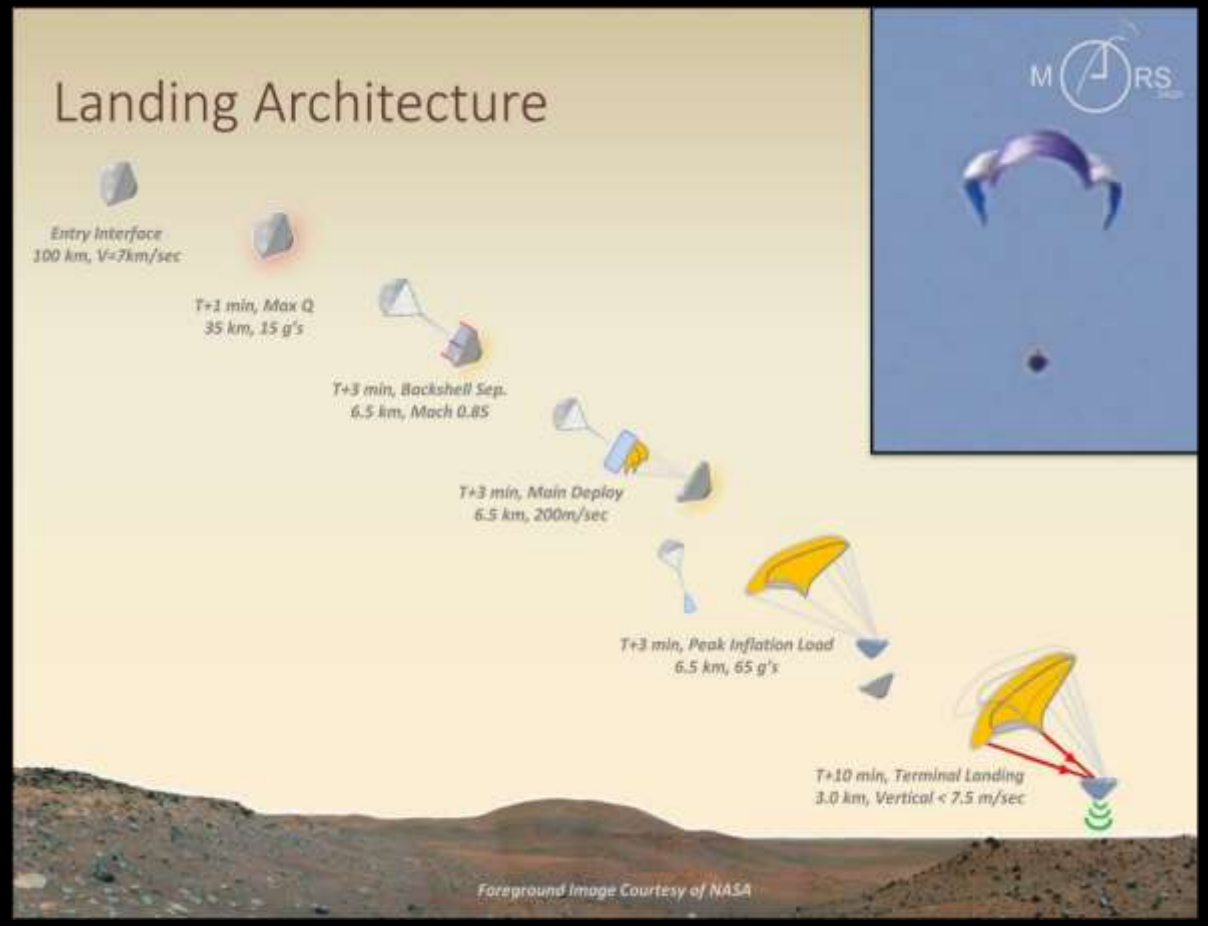
- Engineering criteria are met.
- Lacustrine setting is high BPP site
- Well defined geologic context and excellent stratigraphic exposure
- Exhumed terrain indicates deposits were protected from irradiation, although timing of exposure is unconstrained.
- Proximity to diversity of ROI science targets (7 in ellipse, 4-6 accessible in nominal <13 km traverse)
- 90% of ellipse is high priority ROI targets, meaning the mission will be devoted to hypothesis testing using the scientific payload, rather than traversing to science targets

Landing Site Factor	Mars 2020 Mission and Decadal Priority Science Factors																				
	Environmental Setting for Biosignature Preservation and Taphonomy of Organics								Type 1A & 1B Samples: Aqueous Geochemical Environments indicated by Mineral Assemblages								Type 2 Samples: Igneous		Context: Martian History Sampled, Timing Constraints				
	Deltaic or Lacustrine (perennial)	Lacustrine (evaporitic)	Hydrothermal (<100°C) surface	Hydrothermal (<100°C) subsurface	Pedogenic	Fluvial/Alluvial	No diagenetic overprinting	Recent exposure	Crustal phyllosilicates	Sedimentary clays	Al clays in stratigraphy	Carbonate units	Chloride sediments	Sulfate sediments	Acid sulfate units	Silica deposits	Ferric Ox./Ferrous clays	Igneous unit (e.g. lava flow, pyroclastic, intrusive)	2nd Igneous unit	Pre- or Early-Noachian Megabreccia	Oldest stratigraphic constraint	Youngest stratigraphic constraint	Stratigrapy of units well-defined	Dateable surface, volcanic (unmodified crater SFD)
SW Melas	●	●		≈	≈	●	●	●			?			●		●	?				?	EH	●	?

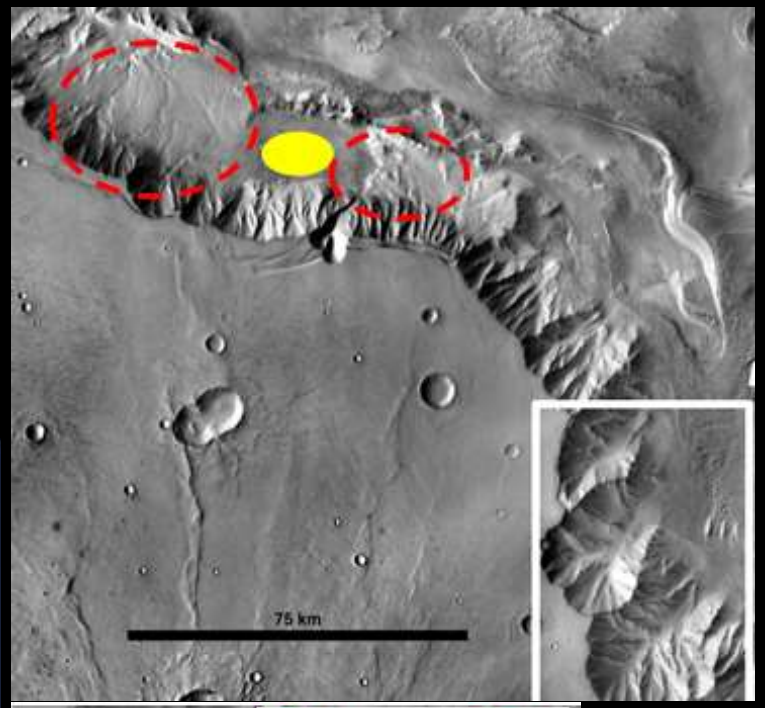
Key	
●	Yes (in-ellipse)
○	Yes (out of ellipse)
	No
≈	Partial Support or Debated
?	Indeterminate
	TBD

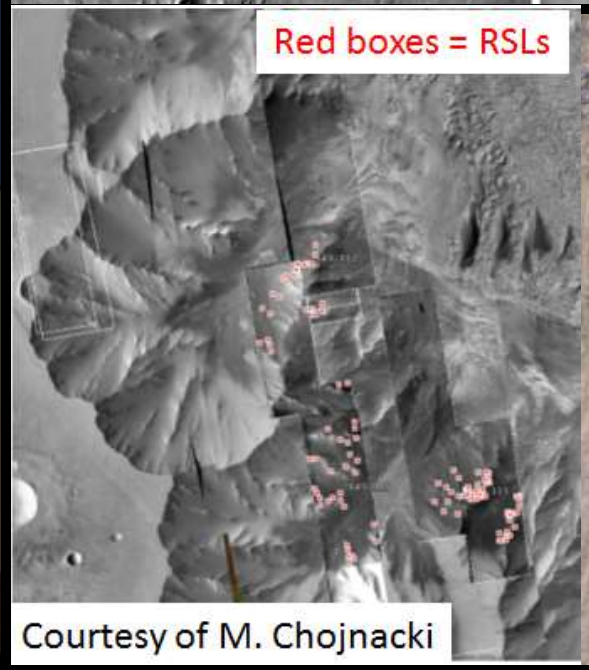
Supplementing Science Return

<u>Consider daughter spacecraft targets:</u>
Source region
Additional scientific targets



(Williams et al., LPSC, 2015)





(Chojnacki et al, LPSC, 2015) (McEwen et al., Nature Geoscience, 2014)

Supplemental Slides

Preliminary Priority Ranking
Regions of Interest within the ellipse

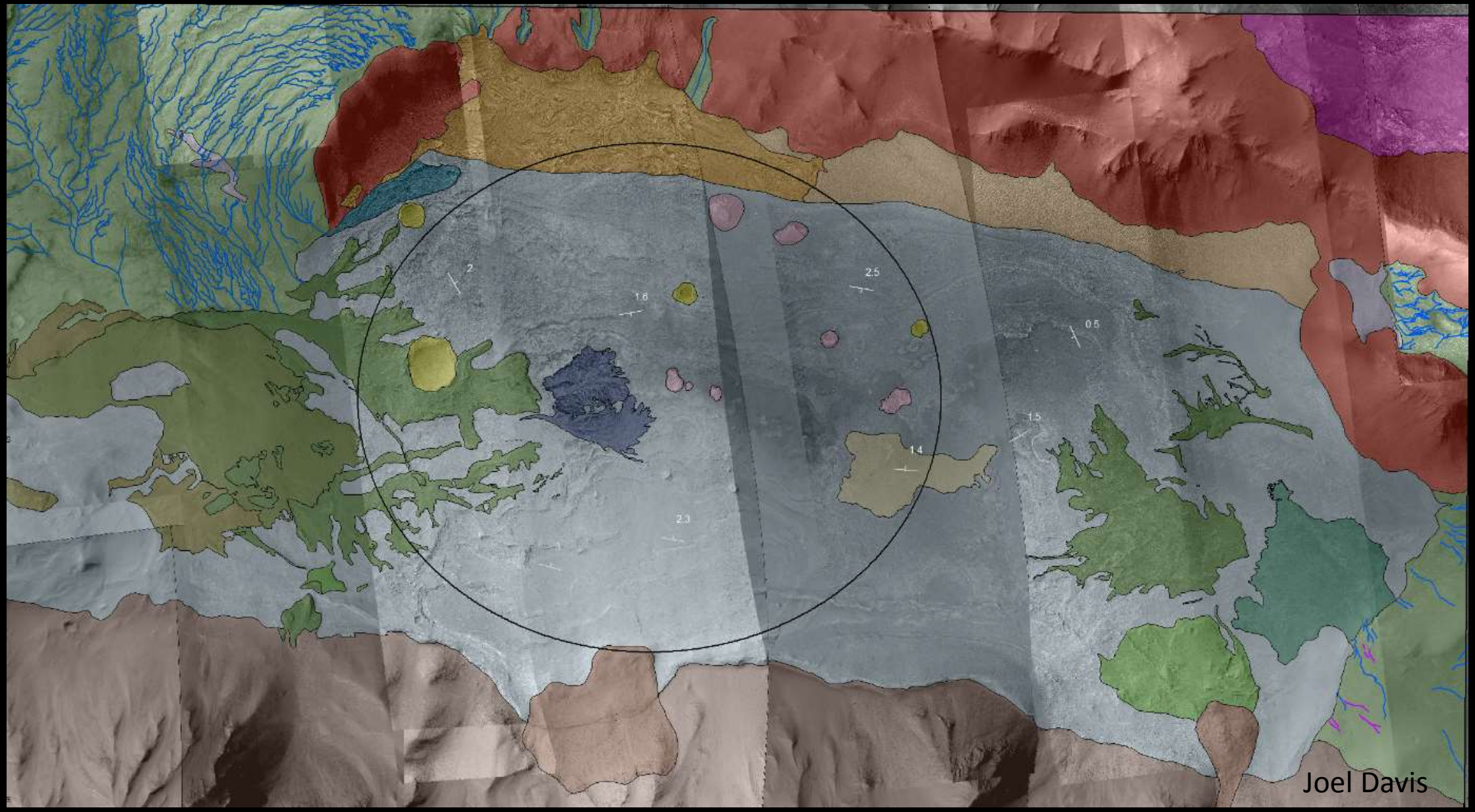
Scientific Target	Notes	Geologic Context	Location/ Areal Extent	2020 Science Objectives	Relative priority
Layered materials (inferred lacustrine deposits; could also include ash deposits)	Sedimentary deposits associated with a former habitable environment that have excellent biosignatures preservation potential. Samples can be collected from a range of stratigraphic levels.	Excellent	2/3 of ellipse, Interbedded with other deposits	A, B, C	1
Fan-Delta	Sedimentary deposits associated with a former habitable environment that have good biosignatures preservation potential.	Excellent	Western 1/3	A, B, C	2
Deep Subaqueous Fan	Sedimentary deposits associated with a former habitable environment that have good biosignatures preservation potential. Two stratigraphically distinct fans could be sampled.	Excellent	~8 km^2 near ellipse center	A, B, C	3
Impact Craters	Impact craters excavate substratum, and in some cases, expose layers that are not accessible elsewhere in the basin.	Excellent	4 craters north of long-axis of ellipse.	A, B, C	4
Hydrated Silica (Opal)	Small, isolated mesas record diagenetic alteration of deposits	Uncertain	Small sites in central and eastern ellipse	Primarily C	5
Landslides	Material shed from valley walls, could represent a diversity of rock types (e.g., impact breccia, volcanic ash, igneous rocks) from early Mars (prior to formation of Valles Marineris).	Excellent	Small location at extreme southern portion of ellipse	Primarily C	6
Convolute Folds (Km-scale)	Interpreted as mass wasted material from valley walls. Aeolian dunes may complicate traversability of this terrain.	Uncertain	Northern ellipse ~4.5 km^2	C	7

*Geologic context is how well the depositional environment or formation conditions are constrained based on analysis to date.

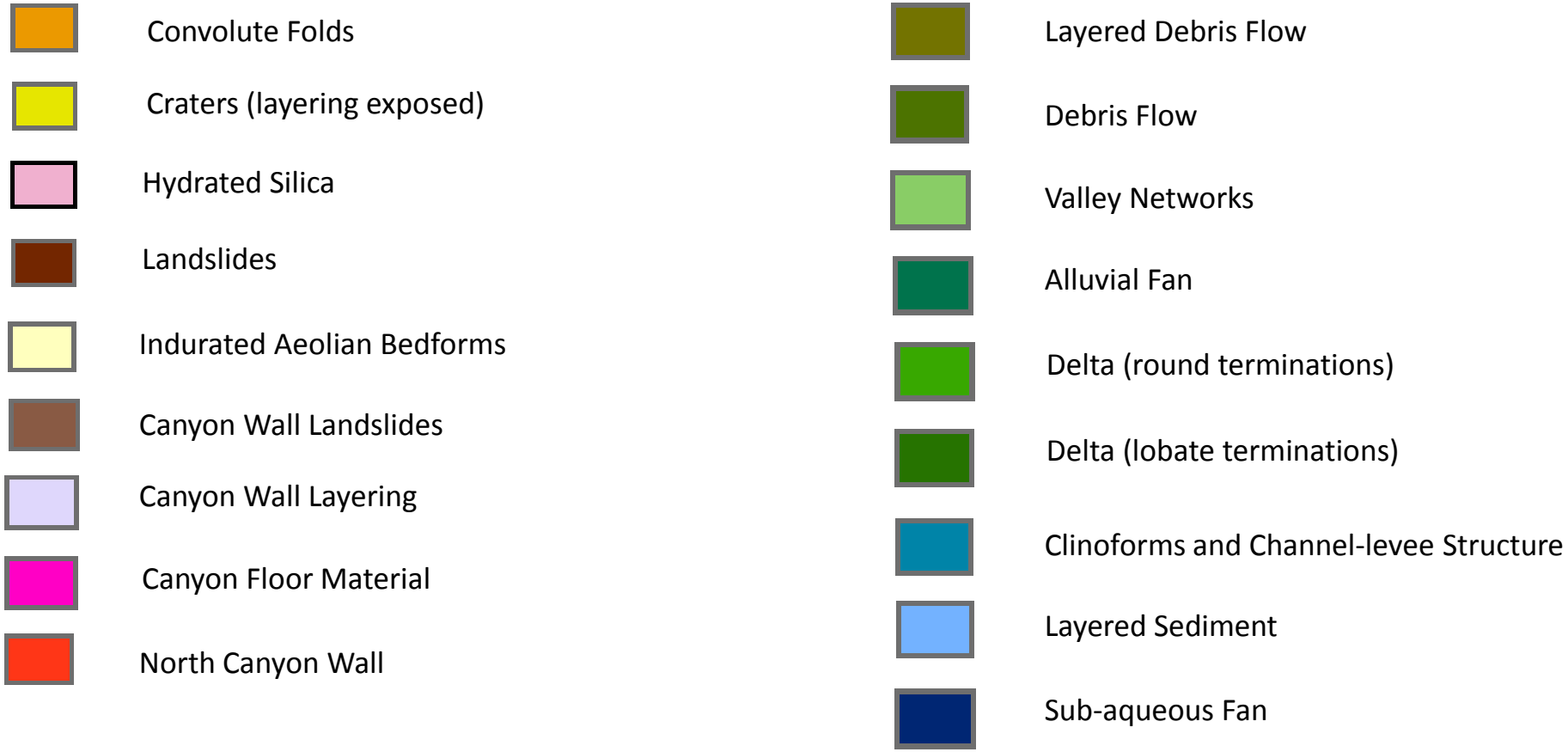
Preliminary Priority Ranking (cont.)
Regions of Interest outside of the ellipse

Scientific Target	Notes	Geologic Context	Distance from Ellipse Center	2020 Science Objectives	Relative priority
Debris Flow	Material shed from valley walls, could represent a diversity of rock types (e.g., impact breccia, volcanic ash, igneous rocks) from early Mars (prior to formation of Valles Marineris).	Excellent	~8 km	C	8
Clinoform & Sulfate deposits	Sedimentary deposits associated with a former habitable environment that have good biosignatures preservation potential. Aeolian dunes may complicate traversability to this terrain.	Very Good	~9 km	A, B, C	9
Wall Rock	Could represent a diversity of rock types (e.g., impact breccia, volcanic ash, igneous rocks) from early Mars (prior to formation of Valles Marineris).	Good	~ 8 km	C	10
Valley Networks	Long-term, extended mission target of scientific interest to explore source region.	Excellent	~20 km	A, B, C	11

Geomorphic Map



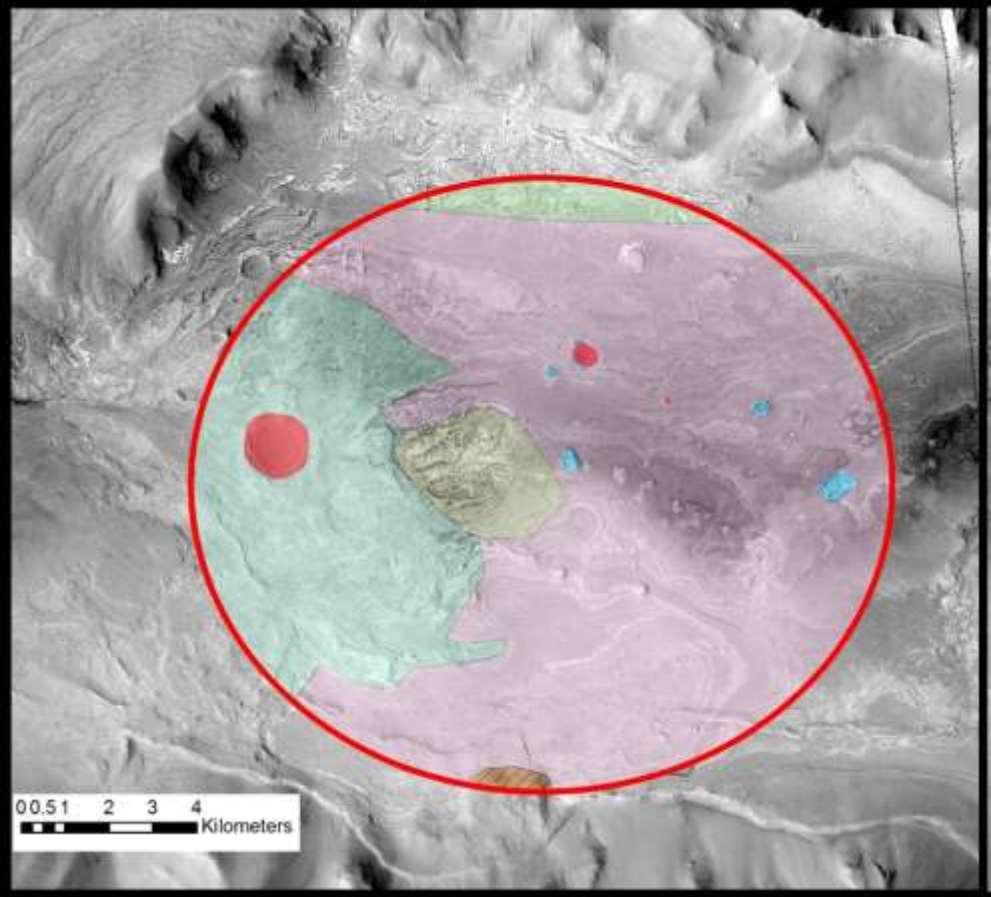
Key to colours

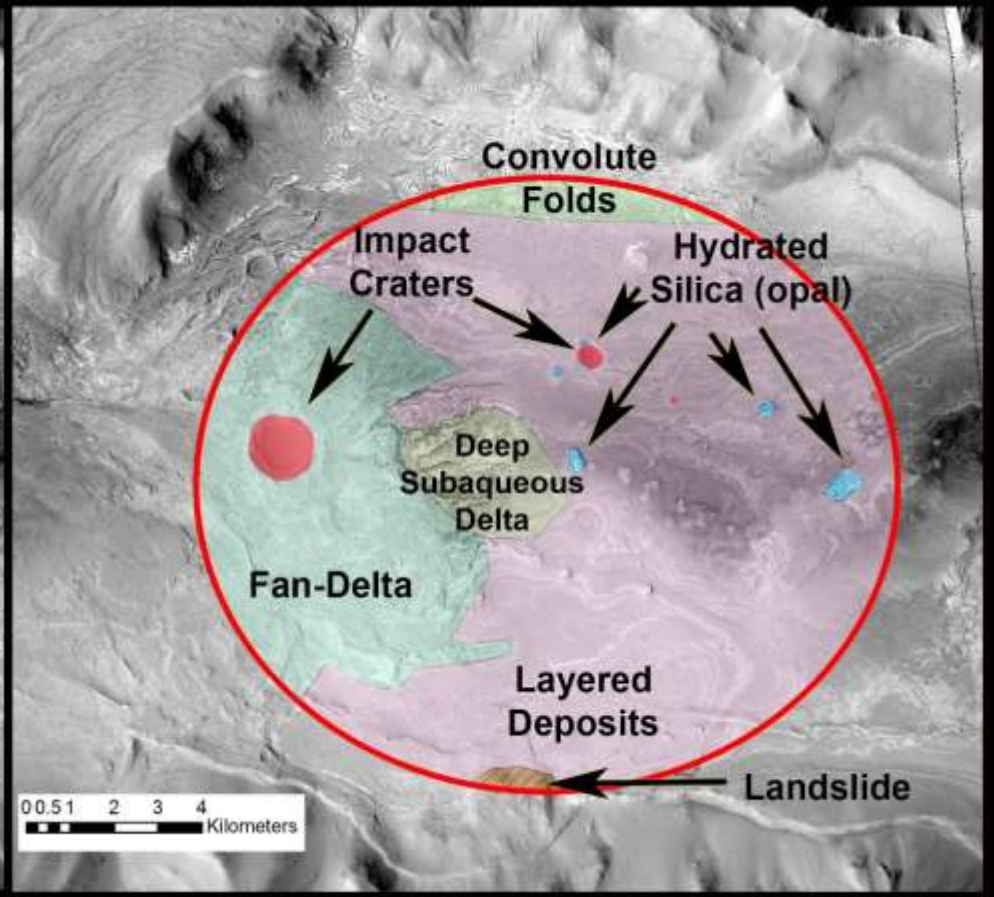


Joel Davis

Terrains within landing ellipse

Ellipse center: 9.82 S, 76.48 E

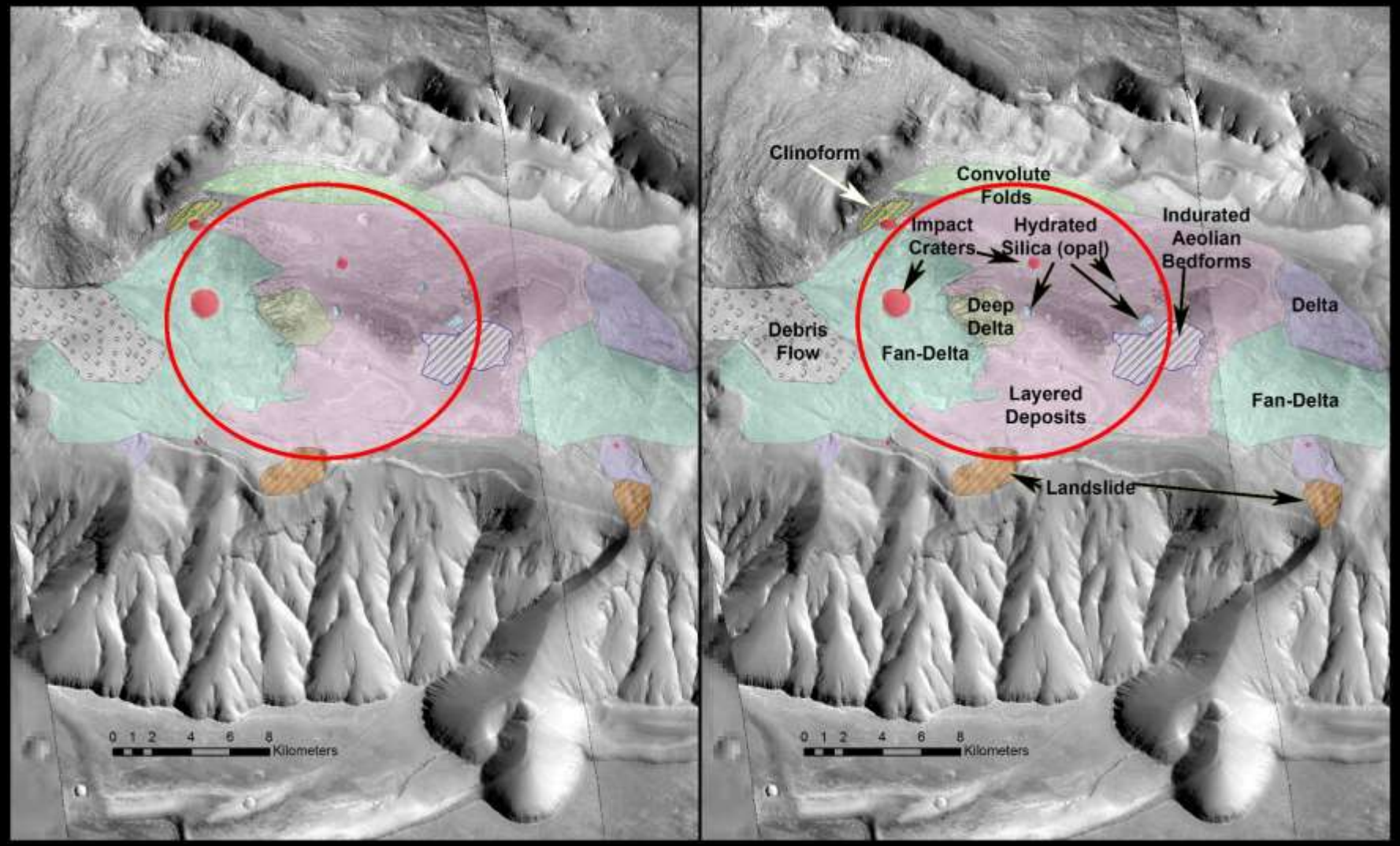




Mapping submitted to JPL January 2015

Becky Williams

Terrains outside landing ellipse



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